

# CENG3420 Homework 1

**Due:** Feb. 4, 2026

All solutions should be submitted to the blackboard in the format of **PDF/MS Word**.

**Q1** (10%) This is a question about integrated circuit cost. Assume that a wafer contains 2000 dies and a die has 0.2 defects on average, please answer the following sub-questions. (retain the results with three decimal places).

1. Calculate the yield of this wafer: Yield1. Assume the yield is estimated with  $\frac{1}{(1 + \frac{\text{Defects per area} \times \text{Die area}}{2})^2}$ . (5%)
2. Assume that you spend 10 millions HKD on manufacture under the yield of Yield1, how much money can you save to manufacture the same amount of dies if the average defects of a die can be reduced to 0.1? (5%)

**Q2** (10%) Suppose we developed a new processor that has 75% of the capacitive load of the older processor. Further, it has 20% reduction in voltage and 10% reduction in frequency, compared with the older processor. What is the impact on dynamic power? Give the ratio of  $\frac{\text{Power}_{\text{new}}}{\text{Power}_{\text{old}}}$ .

**Q3** (20%) We have an `int` (32 bits) array named `arr0` saved in memory. The pointer (address) of `arr0`'s first element is stored in register `a0`. Please answer the following questions.

1. How to put the 4th element of `arr0` to register `a1`? (5%)
2. How to calculate `a1 - 32` and store the result in register `a2`? (5%)
3. Assuming the value in register `t2` is unsigned value, find an efficient way to calculate `t2/32` and `t2%32`, and store the results in `t3` and `t4`. Where `/` is an integer division and `%` is the modulo operation. (hint: use shift and logical operations) (10%)

**Q4** (20%) We have an `int` (32 bits) array named `arr1`. The pointer to `arr1`'s first element stored in register `a0`. We also have the registers `t1 = 0xAAABCDEF`, `t2 = 0xFFA00000`. Please answer the following questions:

1. What is the value of `t3` for the following sequence of instructions? (5%)

```
slli t3, t1, 8  
srlt t3, t3, 8
```

2. What is the value of `t3` for the following sequence of instructions? (5%)

```
slli t3, t2, 8  
srai t3, t3, 8
```

3. Write a piece of assembly program to: (10%)

- Store the result of `t1 XOR t2` to register `t3`; (3%)

- Store  $t_3$  to the first element of  $\text{arr1}$ ; (3%)
- Store the lowest 8 bits of  $t_3$  to the third element of  $\text{arr1}$ . (4%)

**Q5** (20%) Consider the following RISC-V instructions:

```

li t1, 4
li t2, 1
li t3, 0
LOOP:
beq t1, t3, DONE
mul t2, t2, t1
addi t1, t1, -1
jal ra, LOOP
DONE:
# end of the program

```

1. How many times is the **whole** loop executed (between LOOP and DONE)? (5%)
2. List the value of  $t_2$  after each loop. (10%)
3. What does this program do? (5%)

**Q6** (20%) This is a question about using stack. Write RISC-V instructions to implement the following functionalities.

1. Reserve a stack area that can save 4 words of data (1 word = 4 bytes). (5%)
2. Store the return address in  $ra$ , data in  $a_0$  and data in  $a_1$  to the stack. (5%)
3. Restore the return address and data in the stack to corresponding registers. (5%)
4. Free the reserved stack space. (5%)

1.1 the required yield =  $\frac{1}{(1 + \frac{0.2}{2})^2}$   
 $= \frac{100}{121}$   
 $\approx 0.826$

1.2 Money saved =  $10000000 \left( \frac{(1 + \frac{0.1}{2})^2}{(1 + \frac{0.1}{12})} - 1 \right) \left( \frac{1}{2000} \right) (2000)$   
 $\approx 975056.689$  HKD

2 The required impact is  
 $= \frac{\frac{1}{2}(0.75)(0.8)^2(0.9)}{\frac{1}{2}(1)(1)^2(1)}$   
 $= 0.432$

3.1  $|w a|, 4(a0)$

3.2 addi a2, a1, -32

3.3 t2/32: srli t3, t2, 5  
 t2%32: andi t4, t2, 31

4.1 0x00ABCDEF

4.2 0xFFA00000

4.3 1. xor t3, t1, t2  
 2. sw t3, 0(a0)  
 3. andi t4, t3, 255  
 sw t4, 8(a0)

5.1 4 times

loop	t2
1	4
2	12
3	24
4	24

5.3 calculate the factorial of value of t1

6.1 addi sp, sp, -16

6.2  
sw ra, 0(sp)  
sw a0, 4(sp)  
sw a1, 8(sp)

6.3  
lw ra, 0(sp)  
lw a0, 4(sp)  
lw a1, 8(sp)

6.4 addi sp, sp, 16